Water Temperature in the Columbia and Snake Rivers

Problem Assessment

Water Quality Standards

Colville Confederated Tribes

Idaho

Oregon

Washington

Canadian Border

Grand Coulee Dam

Chief Joseph

Wells

Priest Rapids Dam

OR/WA Border

Pacific Ocean

Temperature shall not exceed 16 Degrees C due to human activities.

WA and Colville WQS

Temperature shall not exceed 18 Degrees C due to human activities.

WA and Colville WQS

Temperature shall not exceed 20 Degrees C due to human activities.

WA WQS

Temperature shall not exceed 20 Degrees C due to human activities.

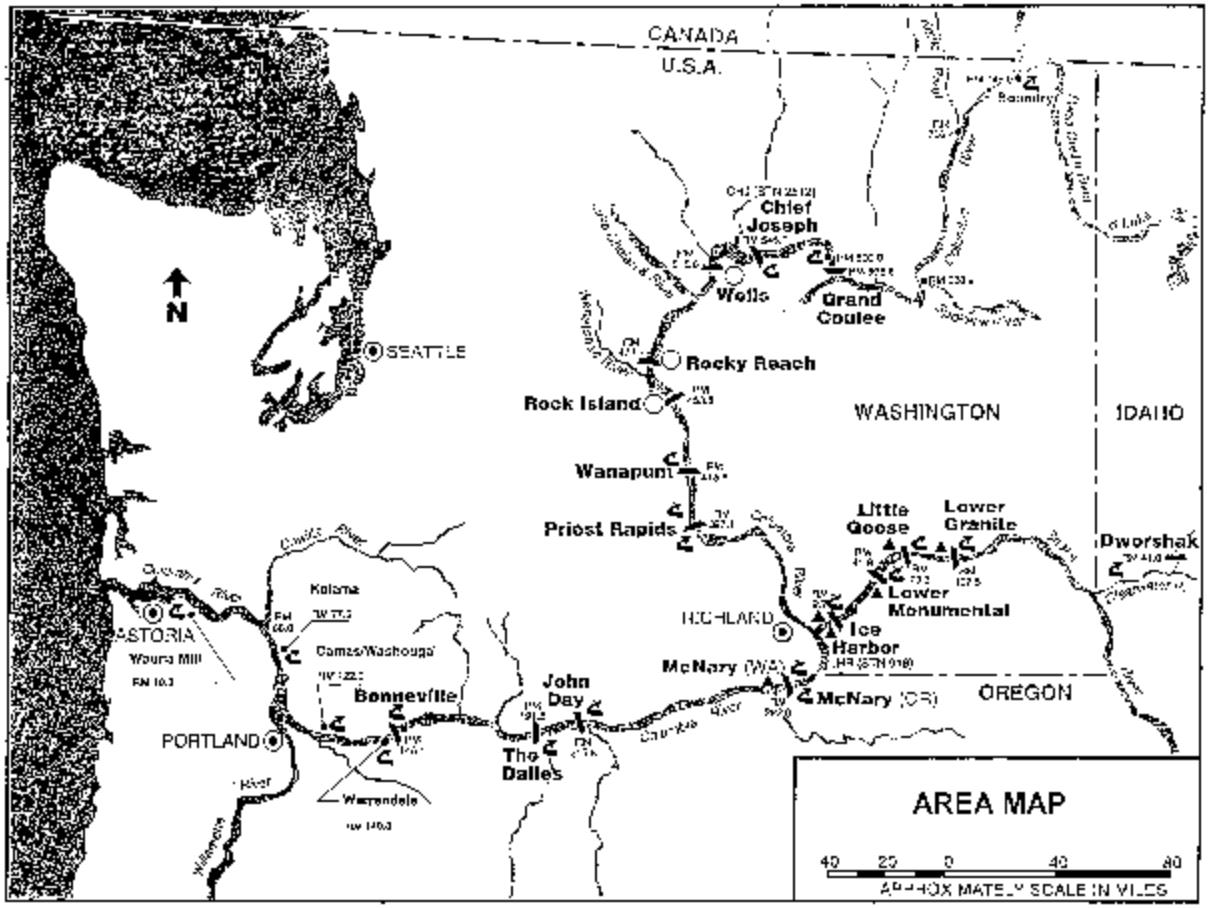
WA WQS

No measurable surface water temperature increase resulting from anthropogenic activities is allowed when temperatures exceed 20 degrees centigrade (7 day running average of the daily maximums)

OR WQS

Salmon River		
	22 Degrees C Maximum **19 Degrees C Daily Average**	**ID WQS**
	No measurable surface water temperature increase resulting from anthropogenic activities is allowed when temperatures exceed 17.8 degrees centigrade from July 1 to Sept 30 and 12.8 Degrees C from Oct 1 to June 30.	**OR WQS**
OR/WA/ID Border		
	22 Degrees C Maximum **19 Degrees C Daily Average**	**ID WQS**
	Temperature shall not exceed 20 Degrees C due to human activities.	**WA WQS**
WA/ID Border		
	Temperature shall not exceed 20 Degrees C due to human Activities.	**WA WQS**
Columbia River		

Area Map


CANADA
U.S.A.
N
SEATTLE
Chief Joseph
Wells
Grand Coulee
Rocky Reach
Rock Island
WASHINGTON
IDAHO
Wanapum
Priest Rapids
Little Goose
Lower Granite
Dworshak
Lower Monumental
Ice Harbor
RICHLAND
McNary (WA)
McNary (OR)
OREGON
John Day
The Dalles
Bonneville
Camas/Washougal
Kalama
ASTORIA
Wauna Mill
PORTLAND
Warrendale
Columbia River
Willamette River
AREA MAP
40 20 0 40 80
APPROXIMATELY SCALE IN MILES

Does water temperature in the Columbia and Snake Rivers exceed Water Quality Standards?

Existing Data

McKenzie and Laenen (1998) assembled temperature data from 84 stations along the Columbia and Snake Rivers within the study area.

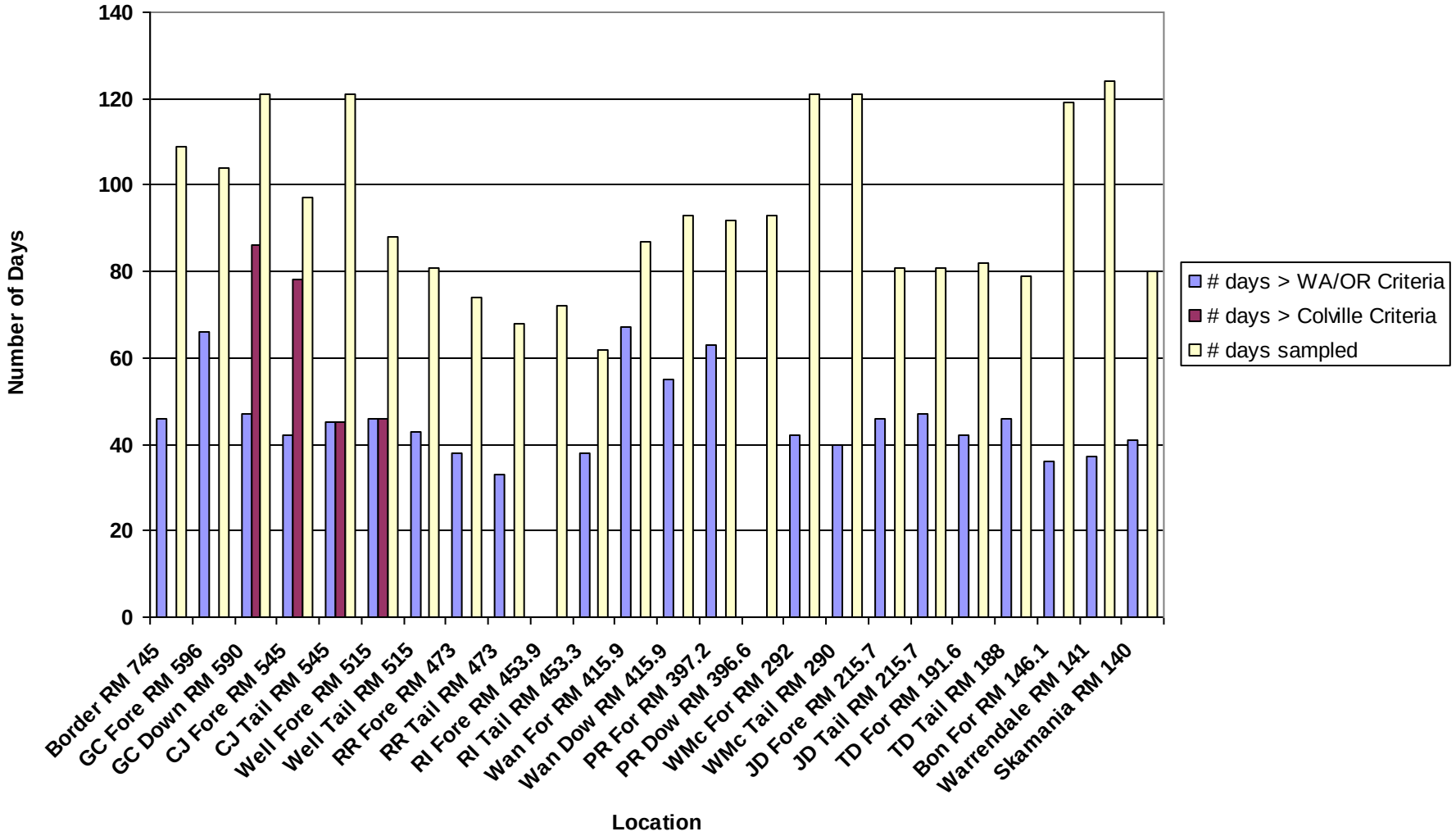
They collected data from all the dams, many USGS stations and a number of other stations.

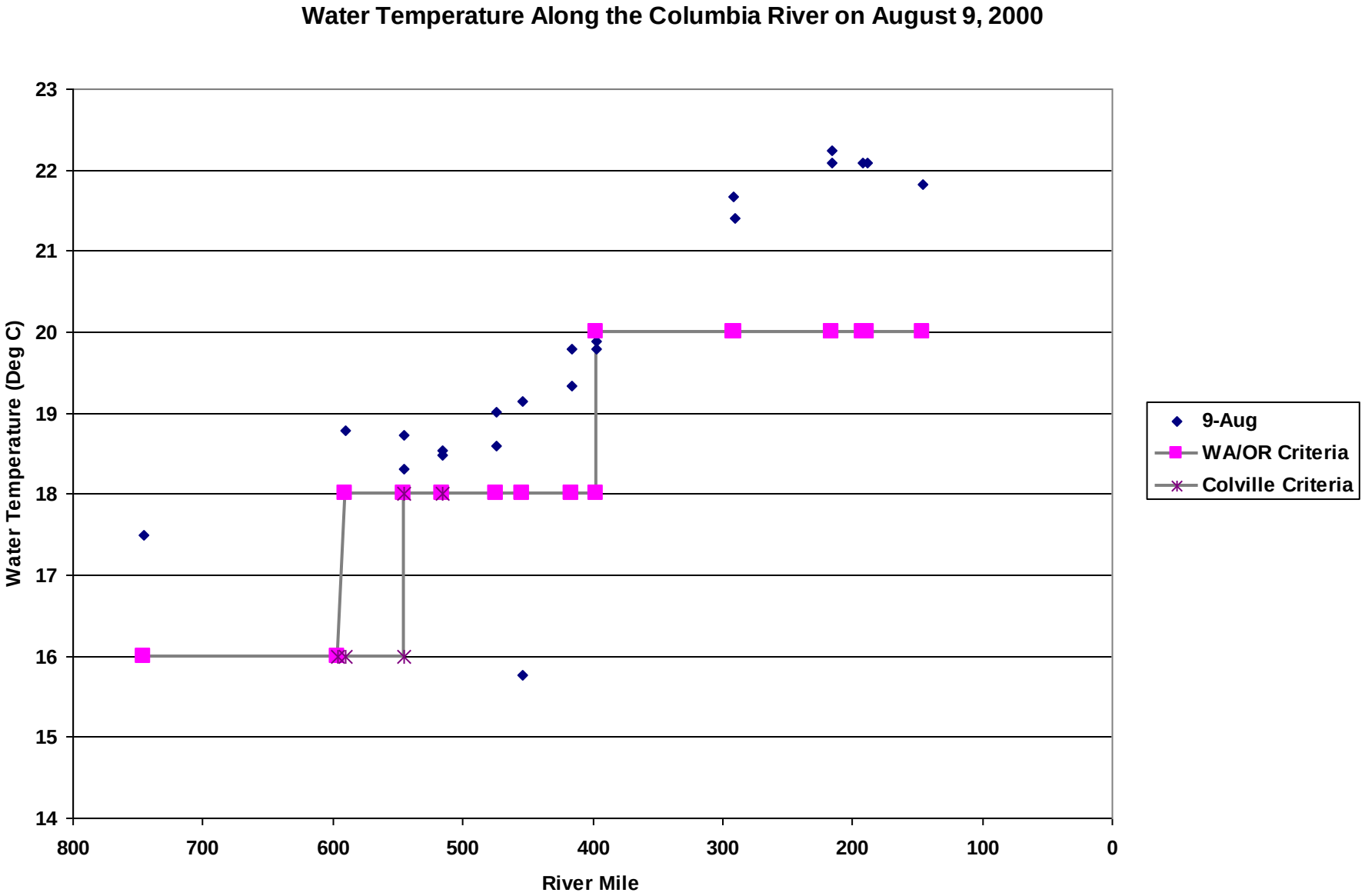
Rock Island Dam data dates to 1933.

Bonneville Dam data dates to 1938.

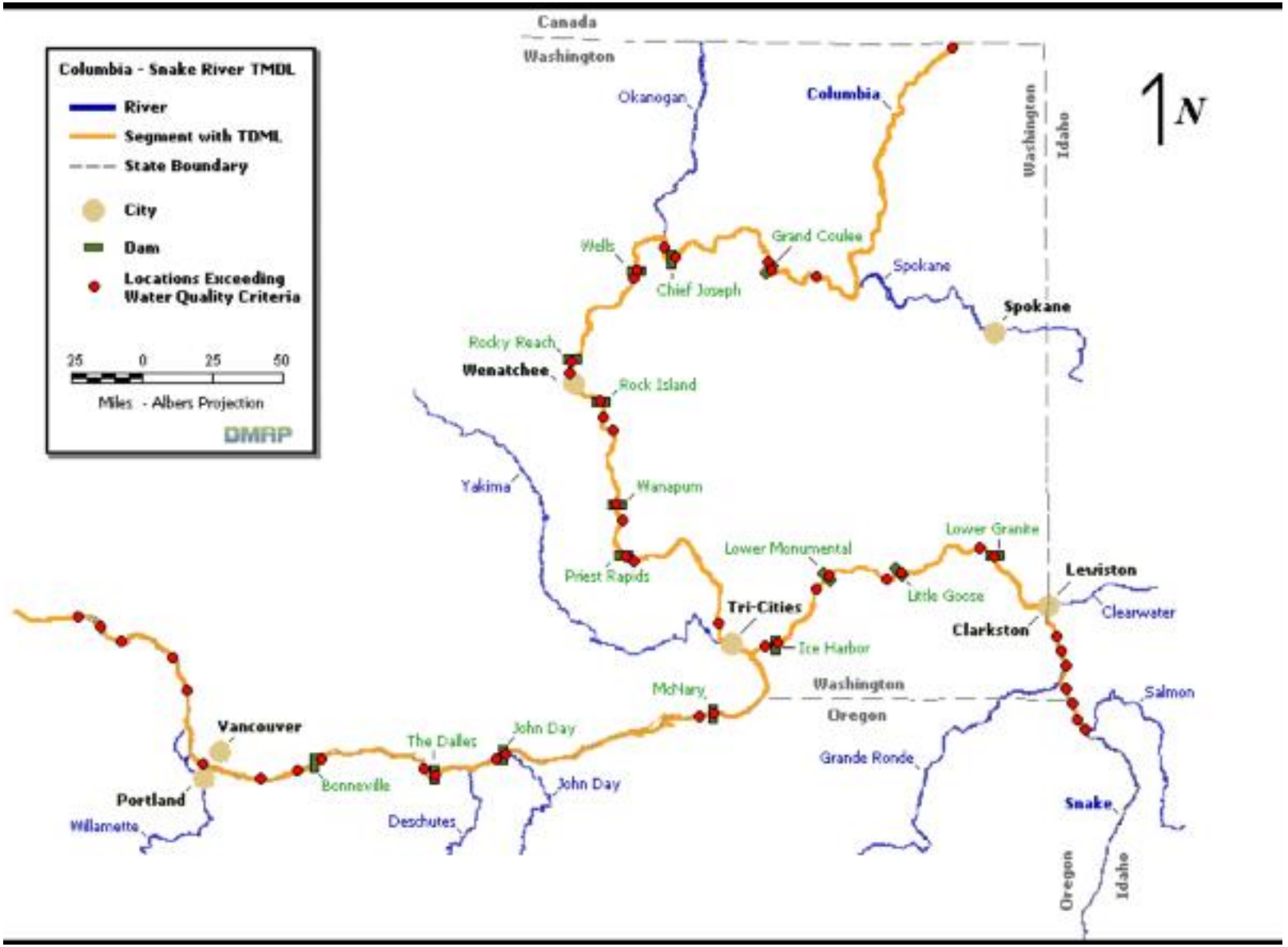
Location	Exceeds Water Quality Criterion		Record Length
	Frequency	Magnitude	
Lower Granite Dam	0.15	2.04	5/30/88-9/17/96
Little Goose Dam	0.15	2.49	5/30/88-9/16/96
Lower Monumental Dam	0.18	2.10	5/29/88-9/17/96
Ice Harbor Dam	0.18	2.35	5/29/88-9/23/96
Wells Dam	0.10	0.87	4/18/93-9/2/97
Priest Rapids Dam	0.18	1.61	4/28/88-12/31/97
McNary Dam	0.17	1.65	4/2/85-12/31/97
John Day Dam	0.15	1.65	4/17/84-9/16/97
Bonneville Dam	0.14	1.39	4/3/86-11/2/97

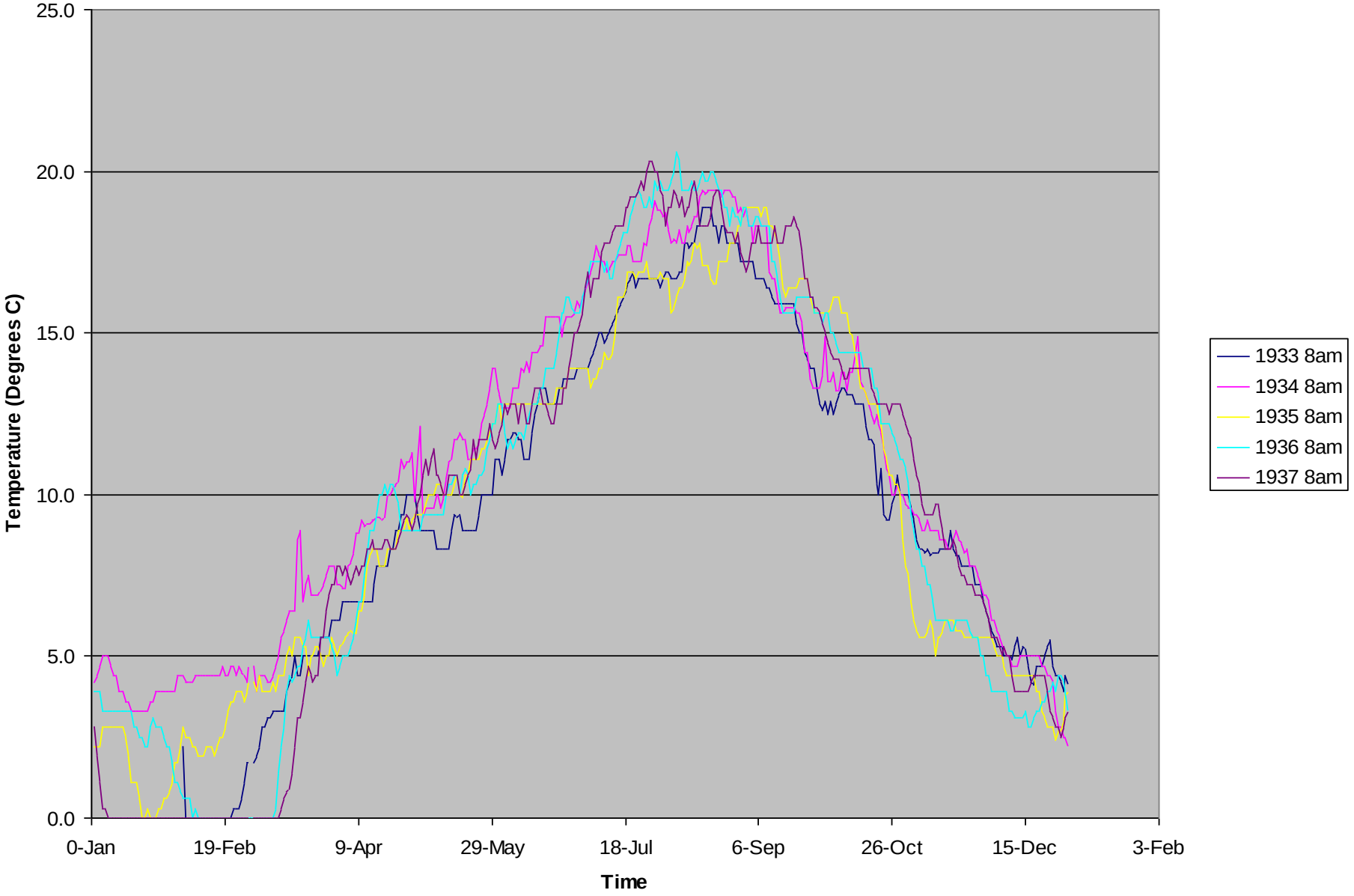
July Through October, 2000 - Number of Days during which Water Temperature along the Columbia River Exceeded Water Quality Criteria

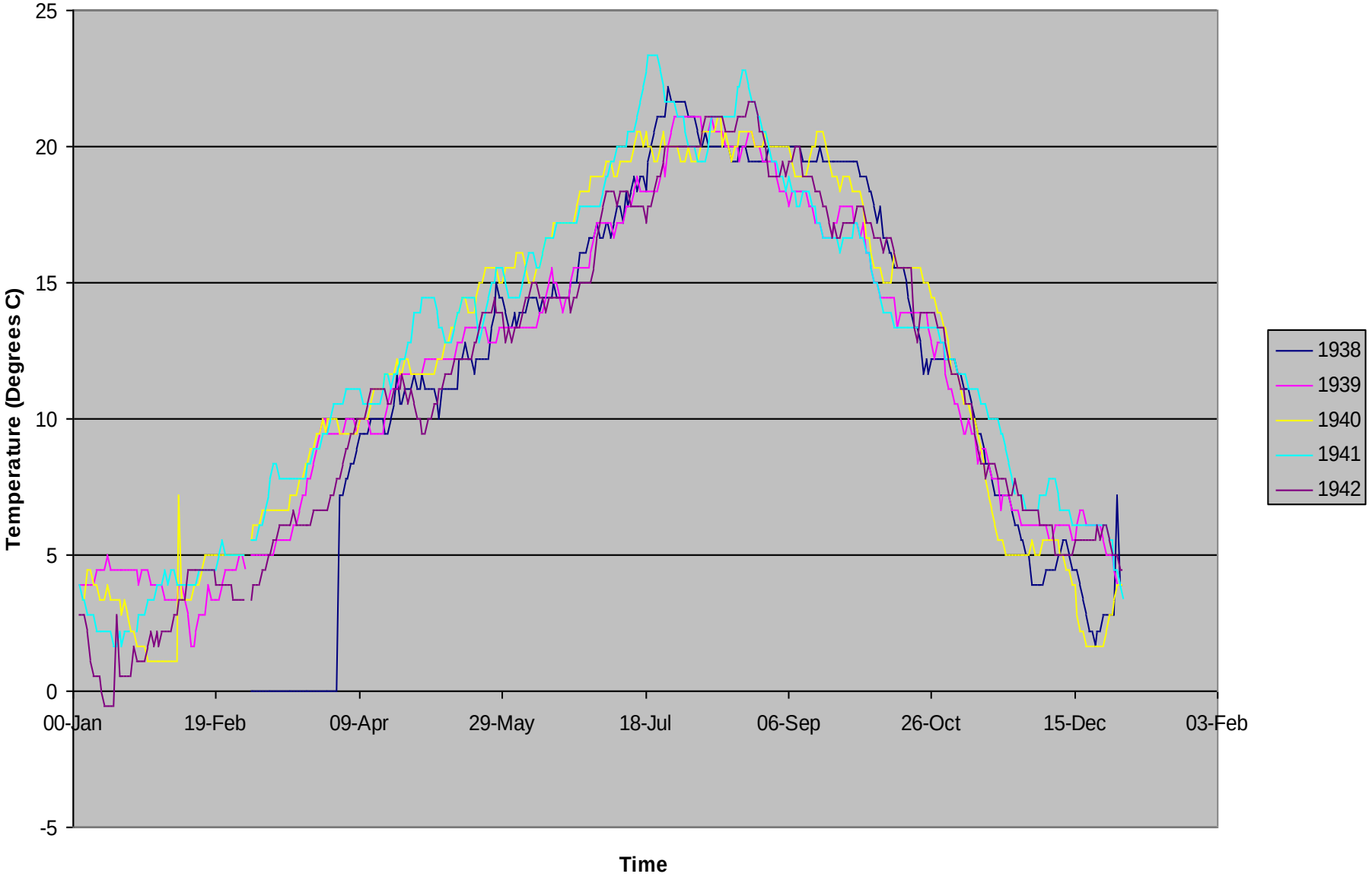


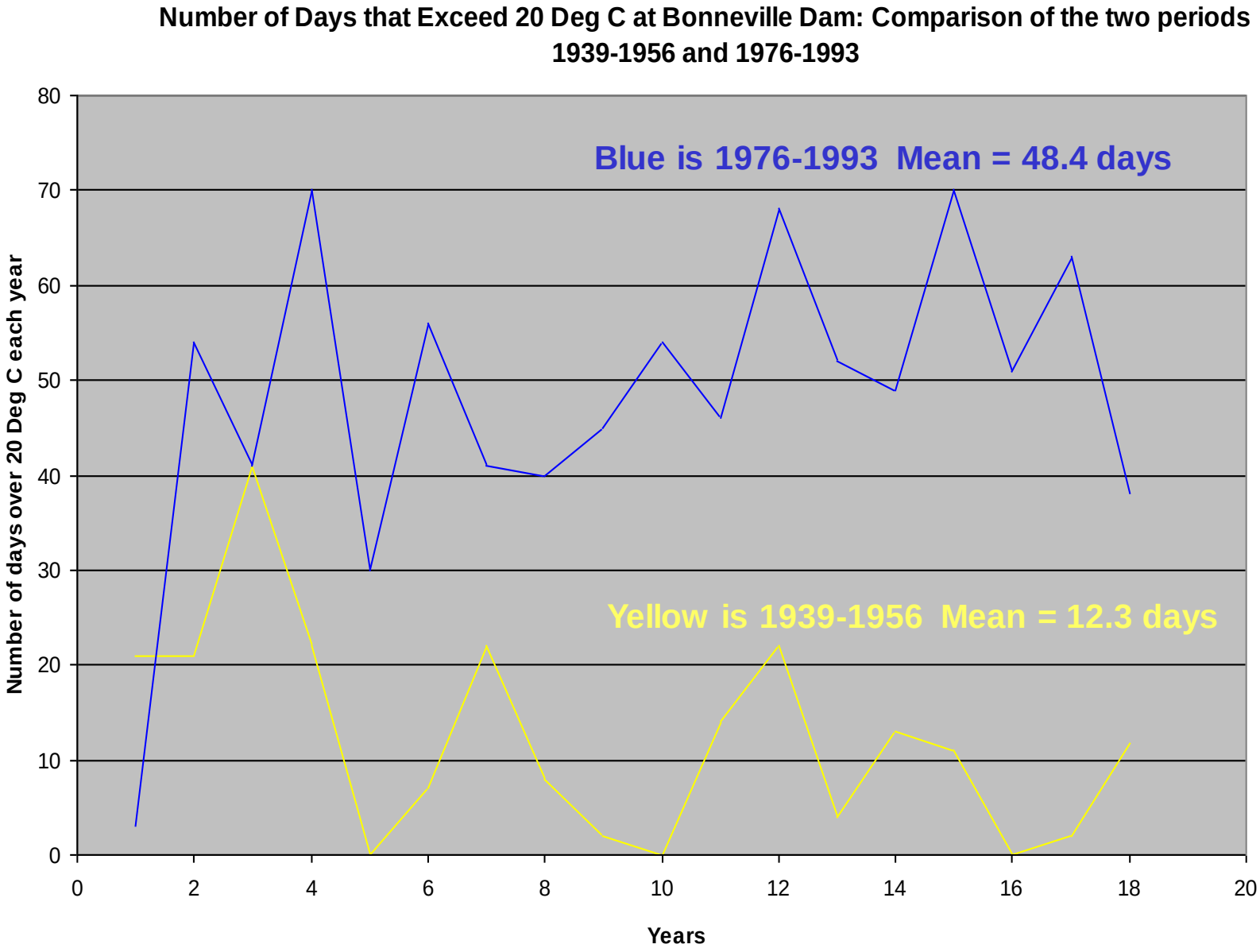

Water Temperature Along the Columbia River on August 9, 2000
Water Temperature (Deg C)
23
22
21
20
19
18
17
16
15
14
800
700
600
500
400
300
200
100
0
River Mile
9-Aug
WA/OR Criteria
Colville Criteria

Geographic Scope




Temperature at the Rock Island Dam Scroll Case 1933 - 1937
25.0
20.0
15.0
10.0
5.0
0.0
Temperature (Degrees C)
0-Jan
19-Feb
9-Apr
29-May
18-Jul
6-Sep
26-Oct
15-Dec
3-Feb
Time
1933 8am
1934 8am
1935 8am
1936 8am
1937 8am


Water Temperature at Bonneville Dam 1938 - 1942
Temperature (Degrees C)
25
20
15
10
5
0
-5
00-Jan
19-Feb
09-Apr
29-May
18-Jul
06-Sep
26-Oct
15-Dec
03-Feb
Time
1938
1939
1940
1941
1942


Number of Days that Exceed 20 Deg C at Bonneville Dam: Comparison of the two periods 1939-1956 and 1976-1993
Blue is 1976-1993 Mean = 48.4 days
Yellow is 1939-1956 Mean = 12.3 days
Number of days over 20 Deg C each year
Years
0
10
20
30
40
50
60
70
80
0
2
4
6
8
10
12
14
16
18
20

Maximum Daily Air Temperature @ Goldendale, WA

Annual Average of the maximum daily temperatures for 1939-1956 and 1976-1993.

	1939-1956	1976-1993
Maximum	65.08 deg F	63.09 deg F
Minimum	57.67 deg F	57.84 deg F
Mean	61.20 deg F	60.69 deg F

Columbia River Flows at Grand Coulee, WA.

Annual Average of the daily average flows for 1939-1956 and 1976-1993.

	1939-1956	1976-1993
Maximum	136298 CFS	132641CFS
Minimum	71147 CFS	80343 CFS
Mean	110150 CFS	102136 CFS

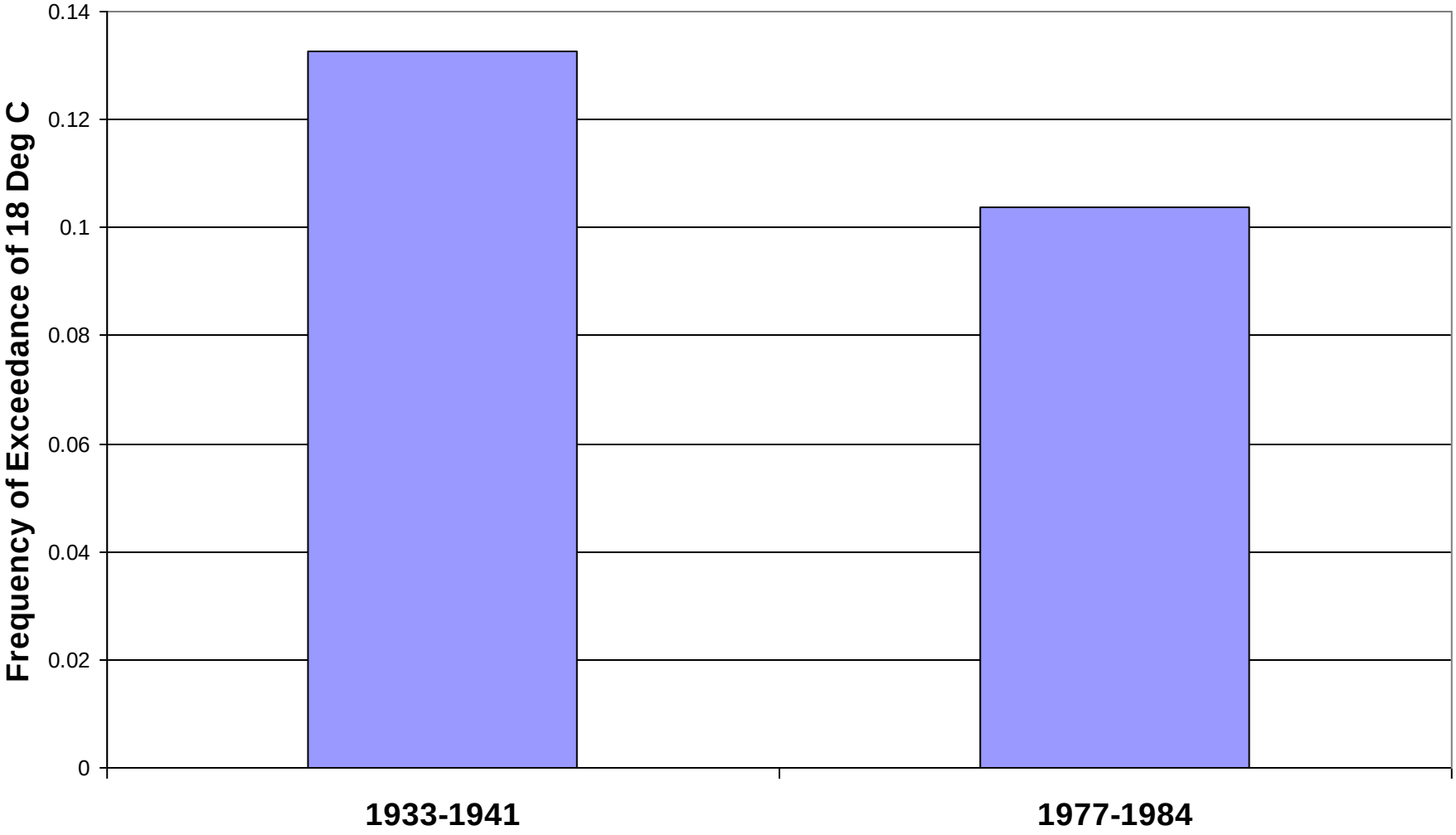
Number of days per year that water temperature exceeded 20 degrees C, and air temperature exceeded 90 degrees F and 80 degrees F

	# Days Water Temp > 20 deg C		# Days Air Temp > 90 deg C		# Days Air Temp > 80 deg C	
	1939-1956	1976-1993	1939-1956	1976-1993	1939-1956	1976-1993
Maximum	41	70	31	33	89	83
Minimum	0	3	3	0	41	49
Mean	12.3	48.4	17.7	18.4	64.3	63.8

Number of days per year that water temperature exceeded 20 degrees C, and river flow was less than 50,000 CFS and 40,000 CFS

	# Days Water Temp > 20 deg C		# Days River Flow < 50K CFS		# Days River Flow < 40K CFS	
	1939-1956	1976-1993	1939-1956	1976-1993	1939-1956	1976-1993
Maximum	41	70	211	54	103	22
Minimum	0	3	5	0	0	0
Mean	12.3	48.4	86.17	13.5	35.28	3.72

Figure 3-6 Frequency of Exceedance of 18 Deg C at Rock Island Dam 1933-1941 and 1977-1984



Looked for literature evaluating trends in Frazer River temperature.

Found Foreman et al (2001):

Ave summer temperature increased 0.012 C from 1941- 1998. This is not significant at the 95% confidence level.

Ave summer temperature increased 0.022 C from 1953 - 1998. This is significant at the 98% confidence level. Most of this warming was attributed to climatic effects.

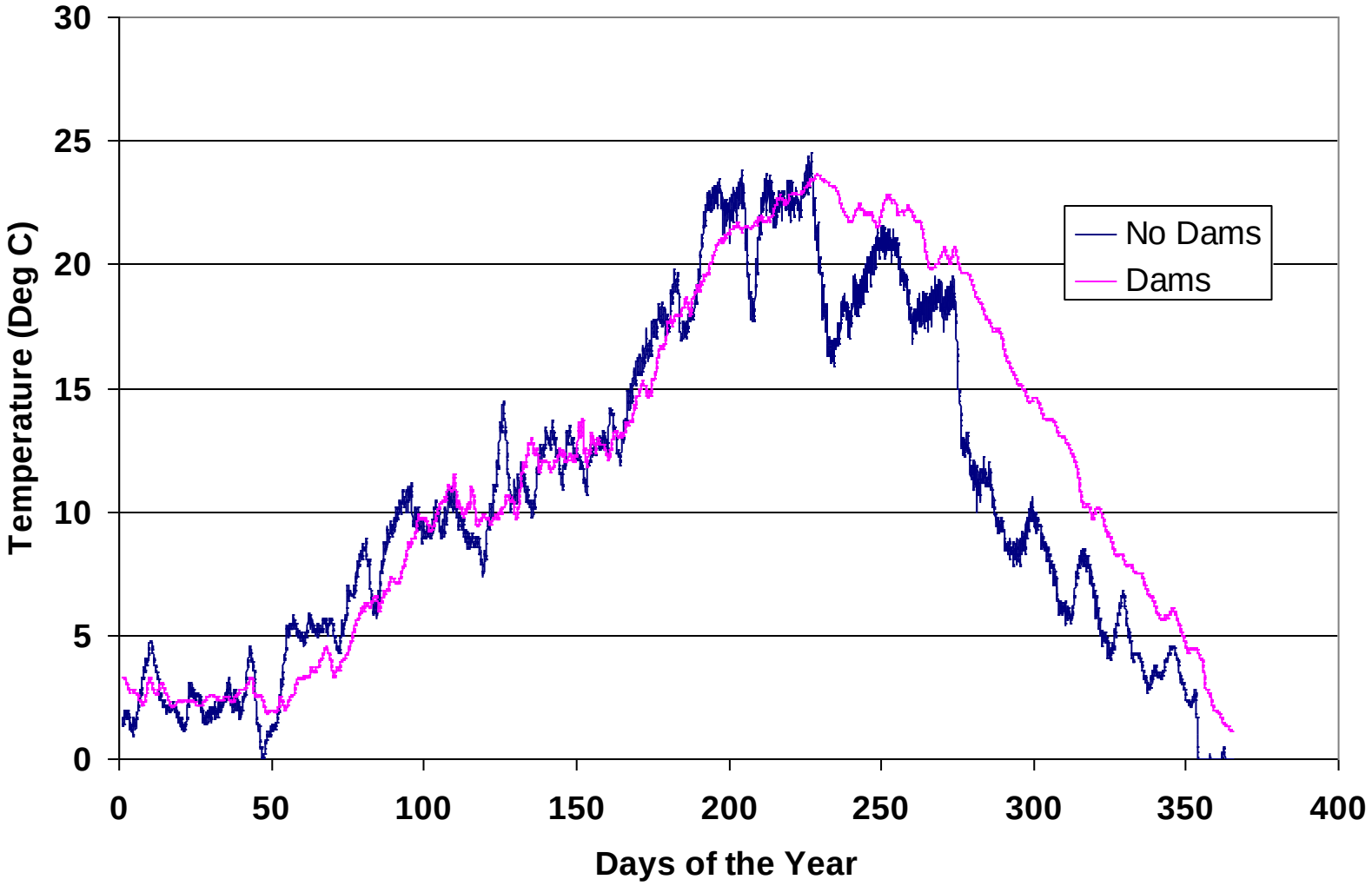
Table 3-5: Temperature measurements from the surface and bottom of the lower Snake River reservoirs near each dam. The data was constructed from figures in Karr et al (1998).

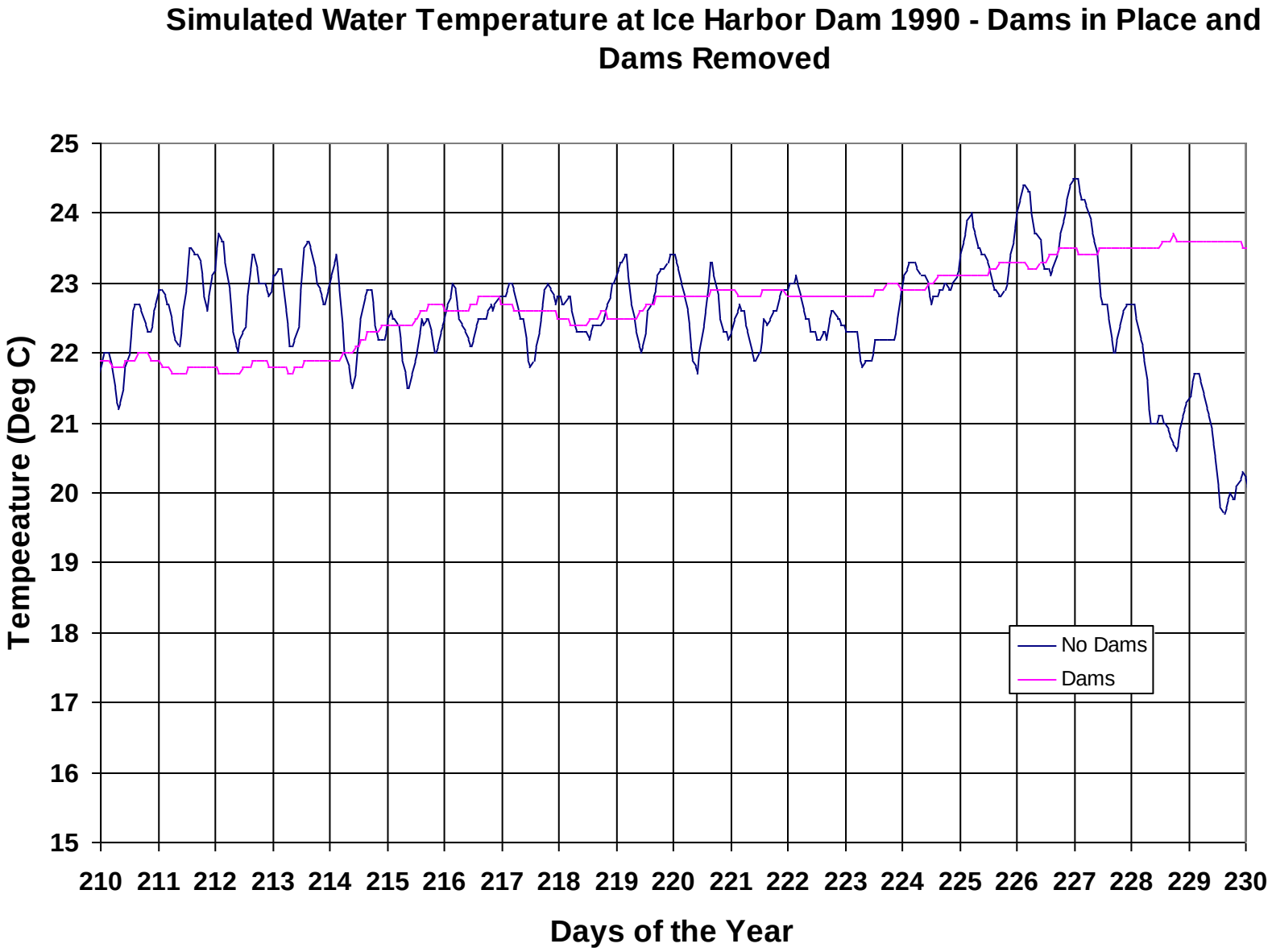
	Lower Granite		Little Goose		Lower Monumental		Ice Harbor	
Date	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
08/08/91	22.2 C	21.1 C	23.8 C	21.1 C	23.3 C	20.5 C	25.5 C	21.1 C
08/23/91	22.2 C	17.7 C	22.7 C	22.2 C	22.7 C	21.6 C	23.3 C	22.2 C
08/27/91	21.1 C	17.7 C	21.6 C	19.4 C	21.6 C	21.6 C	21.6 C	21.6 C

Table 3-6: Mean Monthly temperatures of fish ladders at the four lower Snake River Dams from 1991 through 1994. This figure is taken from Karr et al (1998). The temperature was reported by Karr in deg F and converted here to deg C.

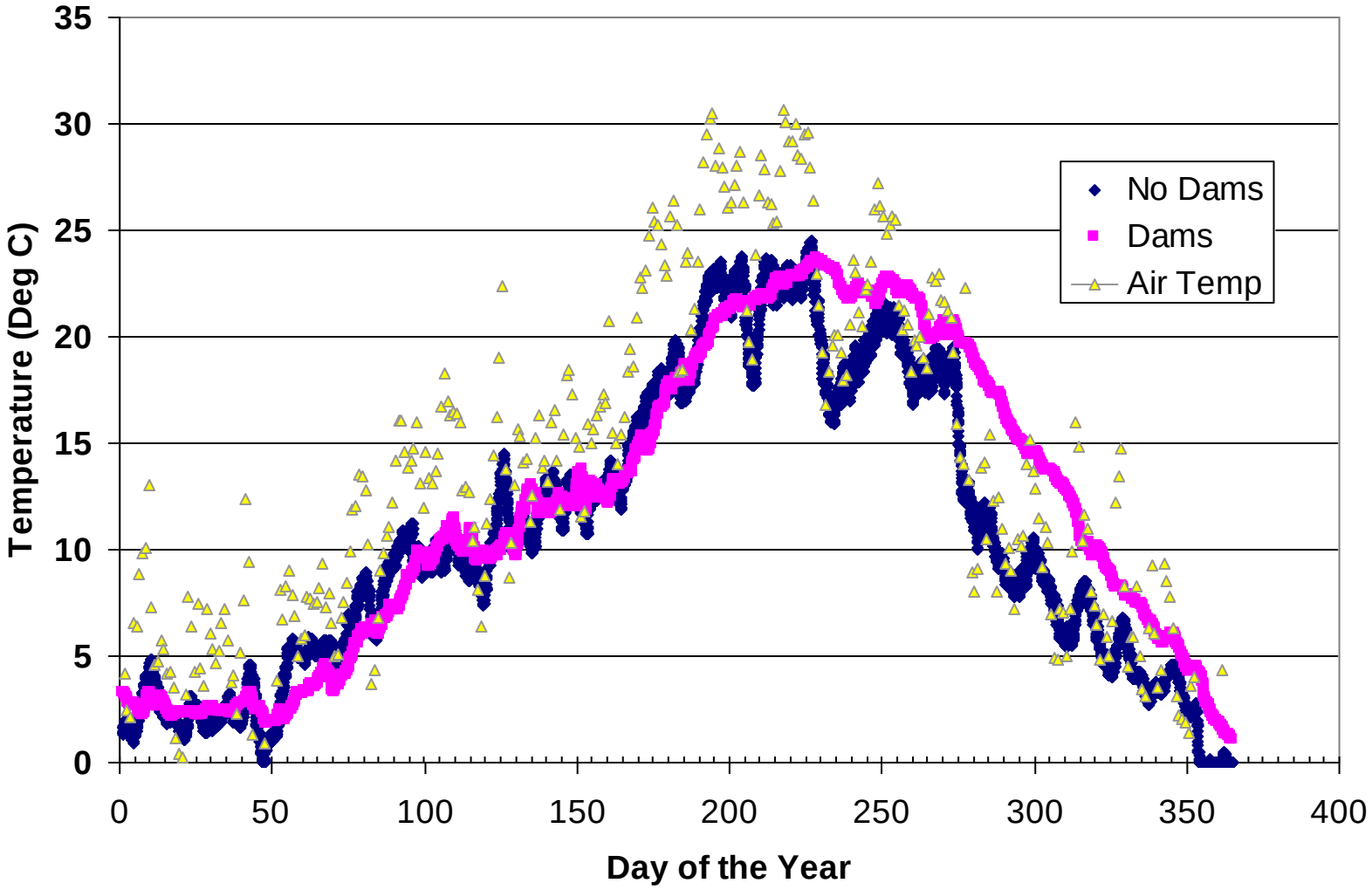
		1991			1992			1993			1994		
Dam	Month	Tailrace	Lower	Upper	Tailrace	Lower	Upper	Tailrace	Lower	Upper	Tailrace	Lower	Upper
Ice	Aug	22.4	23.9		20.8	22.0	22..1	19.4	19.8	20.1	19.5	20.4	20.6
Harbor	Sep	20.3	22.3	20.1	19.7	20.9	19.8	19.1	19.8	19.8	20.0	20.4	20.2
	Oct	16.1	18.7	17.6	15.7	16.0	15.9				17.2	17.3	17.2
Lower	Aug	22.4		22.7	20.7	21.7	21.9	19.1	19.7	20.2	18.4	19.8	19.8
Monu	Sep	20.8		20.6	21.2	19.4	19.8	19.4	19.7	20.0	20.1	20.5	20.6
Mental	Oct	15.7		15.9		15.5	15.7					14.7	17.1
Little	Aug		22.6	22.8	21.1	22.2	22.3	19.1	20.0	20.0	18.5	19.5	19.8
Goose	Sep	19.3	20.1	20.2	18.9	19.2	19.1	20.1	20.6	20.5	20.6	20.8	21.0
	Oct	15.7	18.0	15.9	15.3	15.7	15.5				16.8	17.1	17.2
Lower	Aug	21.1	23.5	23.9	21.7	23.1	23.2	19.2	20.3	20.5	19.8	21.9	21.5
Granite	Sep	18.9	19.2	19.7	17.1	18.8	18.6	19.0	20.6	21.0	20.2	20.7	20.1
	Oct	15.9	18.1	16.8	15.3	15.8	15.8				16.3	16.4	16.6

Figure 3-12. Simulated Water Temperature at Ice harbor Dam 1990 - Dams in Place and Dams Removed




Simulated Water Temperature at Ice Harbor Dam 1990 - Dams in Place and Dams Removed
Tempeeature (Deg C)
25
24
23
22
21
20
19
18
17
16
15
210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230
Days of the Year
No Dams
Dams

Simulations of Water Temperature at Ice Harbor Dam 1990 with Dams in Place and Dams Removed Compared to Air Temperature at Lewiston, ID



How has the Temperature Regime of the River Changed?

- **Longer periods with temperatures in the warm range for coldwater biota;**
- **Temperature gradients in the reservoirs resulting in warm surface water;**
- **Less fluctuation in temperature - daily and in response to meteorology.**
- **Loss of cold water refugia due to flooding of the alluvial flood plains.**